VOL. 29 NO. 4 DECEMBER, 1959

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AGRICULTURAL JOURNAL

So many requests are received for parts of the " Agricultural Journal " which were never published or which are now out of print, that the following list of all issues published is given for reference. Those volumes and numbers which are not now available are marked with an asterisk. It will be noted that copies of all parts of ten volumes and parts of nine other volumes are unobtainable. Should any reader have unwanted copies of these publications, the Librarian would be grateful to receive them.

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7.	1 ,,	1934.	22.	1 ,,	1951.*
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14.	4 ,,	1943* (No. 3).		No issue for	1958.
15.	4 ,,	1944* (No. 2).	29.		1959.

AGRICULTURAL CIRCULAR, 1920-25

NUMBERS and year of issue of the " Agricultural Circular " :—

Vol. 1, 1920, 12 numbers. Vol. 4, 1923, 1 number.
2, 1921, 5 ,, 5, 1924-5, 2 numbers.
3, 1922, 4 ,,

As number 4 of Vol. 3 was printed as " Volume 4 " and number 1 of Vol. 4 as " Volume 5 " it would appear from an inspection of a complete set that Volume 4 comprised only a number 4 and that there were two issues of Volume numbered as 5, No. 1.

ANNUAL BULLETINS, 1931-38

COPIES of Annual Bulletins of Divisional Reports for the year 1933 and 1934 ONLY are availabie.

AGRICULTURAL BULLETINS

A FEW copies of the following bulletins are available at the prices shown. Other Bulletins previously listed are out of print.

No. 7. A Mission to Java for a Coleopterous Pest of Bananas, by Jepson, 1914. Price 2s. 6d
23. Insect Pests of Fiji, by R. J. A. W. Lever, 1946. Price 1s.
24. The Botanical Gardens, Suva, by J. W. Parham, 1948. Price 1s. 6d.
26. Mechanisation of Rice Padi Cultivation by R. R. Mason. Price 2s. 6d.
27. Index to Agric. Journal. Vols. 1–21 by B. E. V. Parham. Price 2s.
28. Soil Erosion and its Control in Fiji, by C. E. Whitehead. Price 2s.
29. Annual Reports of Divisional and Specialist Officers 1954. Price 4s.
30. The Grasses of Fiji, by J. W. Parham. Price 5s.
31. The Declared Noxious Weeds of Fiji and their Control, by T. L. Mune and J. W. Parham. Price 2s. 6d. (Revised Edition).
32. Copra Driers by G. B. Gregory, V. E. Sills and J. A. Palmer. Price 3s.
33. The Koronivia Farm Institute by R. L. Hartley. Price 3s.
34. Annual Reports of Divisional and Specialist Officers, 1957. Price 4s.
35. The Weeds of Fiji by J. W. Parham. Price 5s.

AGRICULTURAL REPORTS

RECENT reports on Agricultural subjects are available as follows :—

Report by Sir Geoffrey Clay on his Visit to Fiji in 1954. C.P. No. 31, 1955. Price 1s. 6d.
The Fisheries Industries of Fiji. C.P. No. 1, 1956. Price 1s.
Department of Agriculture Annual Report for 1955. C.P. No. 8, 1956. Price 2s.
Department of Agriculture Annual Report for 1956. C.P. No. 8, 1957. Price 2s.
Department of Agriculture Annual Report for 1957. C.P. No. 18, 1958. Price 2s.
Department of Agriculture Annual Report for 1958. C.P. No. 9 of 1959. Price 2s.

OTHER PUBLICATIONS

A FEW copies of the following important book are available :—

The Coconut Moth in Fiji, by J. D. Tothill, H. C. Taylor and R. W. Paine. Imperial Bureau of Entomology, 1930. Price £1.

FORTHCOMING PUBLICATION

THE following publication is in the press and will be available shortly :—

Book ... ... The Fishes of Fiji, by H. W. Fowler (approximately 600 pages and 200 illustrations).

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ISSUED BY THE DEPARTMENT OF AGRICULTURE, FIJI

EDITORIAL . . .

Much has been written on the need for conserving our one and only asset—the soil of Fiji—and if progress in this direction were to be measured only by the yard-stick of words, both written and uttered over the past few years, then we have progressed far beyond our dreams. But mere words mean nothing and our progress can only be measured and assessed by the generations that come after us—generations of ever-increasing numbers, each demanding an ever-increasing out-turn from a still-decreasing asset.

Our areas of cultivable soils are limited and will not increase as our population increases; what now supports one man will inevitably, in the future, be called upon to support first two, then three, perhaps then four—truly a depressing prospect as viewed through present eyes . . .

No thinking man can seriously attempt to argue against the measures which have been introduced with effect from 1st January, 1960, to suppress the iniquitous sledge or "ghazita" and to force the planting of sugarcane on the contour; these soil conservation measures are urgent—in fact, years overdue; they have been introduced only after careful consideration and it is up to everyone to give them full and active support.

This issue carries the first of a series of articles on banana cultivation—not, however, "cultivation" as it is practised at present but cultivation as it should be and will have to be practised if bananas are to retain their status as an export industry.

The banana industry is still beset by tradition and the memory of past glories. But what was good enough yesterday is just not good enough today; our haphazard, bush-grown fruit cannot hope to meet up to the requirements of an increasingly selective and competitive market. It has still to be realized that the standards of our export fruit are not set in Fiji; they are set by the people who are buying the fruit and we, as producers, must conform to these standards or get out of the business.

Bananas are an attractive crop, particularly for the small grower; they give a quick return and provide a steady and frequent source of income; in fact, "every shipping day can be a pay day". Though vulnerable to hurricane and flood, they can quickly recover and, in the early stages of establishment or recovery, can be interplanted with food crops. Pests and diseases, as with almost any other crop, are major problems, but by no means beyond control.

What's holding us back?

PUBLICATIONS OF THE FIJI SOCIETY

The Transactions of the Fiji Society cover a wide range of subjects including anthropology, botany, ethnology, geology, history and zoology, with special reference to the research carried out in Fiji and in other Pacific areas.

Volume 5 of the Transactions of the Fiji Society is now available. This volume covers the years 1951 to 1954. Volume 6 of the Transactions will be available later in the year and will bring the publications of the Society up to the end of 1957. Orders are now being received for both volumes. The price per volume is twenty-five shillings (25s.) Fiji currency and this includes postage. Please note that one pound Fijian (£1.F.) is approximately equivalent to two dollars fifty cents ($2·50) U.S. currency.

Volumes 2, 3 and 4 of the Transactions are still available and the price is three pounds three shillings (£3 3s. 0d.) for the set of three volumes. Volume 1 is out of print.

Orders should be addressed to the Hon. Treasurer, Fiji Society, P.O. Box 358, Suva, Fiji.

LOOKING BACK . . .

The Department of Agriculture, Fiji, was established in 1904, though it did not become active in the field until 1905, in which year the staff consisted of two officers and the expenditure allocated to agriculture was £1,212. Compare this with 1959, with a staff establishment of 177 and an allocation of £204,415, exclusive of £10,082 allocated to Special Expenditure and £21,700 to Capital Expenditure.

In the early years the Head of the Department was entitled Superintendent of Agriculture; the title of the post was changed to that of Director of Agriculture in 1930.

It is of interest to record the various officers who have served as Superintendent of Agriculture and, later, as Director of Agriculture from 1904 to the present time:

1904—1921 : Charles Henry Knowles, B.Sc. (London). Appointed Superintendent of Agriculture 29th October, 1904.

1922—1924 : Post Vacant. Various officers acted, including at one time the Commissioner of Works.

1924—1929 : John Douglas Tothill, D.Sc. Director of Levuana Moth Campaign, 1st November, 1924. Acting Superintendent of Agriculture, 1925. Appointed Superintendent of Agriculture 1st November, 1926.

1929—1933 : Arthur Chapman Barnes, B.Sc. (Hons.), F.I.C., A.M.I.Ch.E. Appointed Superintendent of Agriculture 12th July, 1929. Title of post changed to Director of Agriculture 1st July, 1930. Previous Service : East African Protectorate 1914—1919; Kenya 1919—1923; Nigeria 1923—1927; Zanzibar 1927—1929.

1934—1945 : Henry Walter Jack, O.B.E., D.Sc., B.A. (Univ. Coll., Cork). Appointed Director of Agriculture 26th July 1934. Previous Service: Malaya 1914—1934.

1945—1957: Cedric Harvey, C.B.E., B.Sc., (Agric.), (Transvaal Univ. Coll., Pretoria), A.I.C.T.A. Appointed Director of Agriculture 12th February, 1945. Previous Service : Tanganyika 1927—1938.

1958— : John Merryne Watson, O.B.E., M.A. (Cantab), Dip. Agric. (Cantab), A.I.C.T.A., M.Inst.Biol. Appointed Director of Agriculture 21st March, 1958. Previous Service: Uganda 1936—1953; Somaliland Protectorate 1953—1957.

STAFF NOTES

Mr. L. W. Harwood, Senior Agricultural Officer (Cocoa), left Fiji on pre-retirement leave in September after 23 years' service with the Department.

New appointments have included:—

Mr. J. T. Gray, Veterinary Officer and Mr. P. G. Thompson, Agricultural Officer.

Mr. J. W. Deering, Agricultural Officer, was on secondment during the period April to June while engaged on an Agricultural Survey of Pitcairn Island.

Mr. K. J. Garnett, Veterinary Officer, is spending vacation leave in reading for the D.T.A. at the Imperial College of Tropical Agriculture.

Mr. N. M. Williams, Agricultural Officer, resigned his appointment in June.

AGRONOMY . . .

SOME ASPECTS OF BANANA CULTIVATION

BY J. W. McPAUL

This article, which is to be published in two parts, deals with the growing of bananas by the peasant farmer under a system of plantation management. The essentials are :—

The adoption of a definite spacing between stools;
Pruning to a limited number of stems per stool;
The control of weeds, diseases and pests;
The use of fertilizers and organized food production.

Machinery is not essential, although spraying equipment for leaf-spot control will be necessary as the incidence of this disease increases. Spraying should start as early as possible but, in general, the farmer will have to await some return from his crop so that he can purchase the necessary equipment.

PART I

FIELD ASPECTS

Choice of Site—Bananas require a reasonably deep, well drained soil which is not excessively heavy in texture and is preferably of moderate to high fertility. The subsoil, while not impeding drainage, must hold sufficient water to tide the crop over dry periods. Freely drained alluvial soils would be the first choice; the well drained colluvial soils come next, followed by other soils which have reasonable physical properties. Where possible, areas sheltered from strong winds are desirable; this may entail the establishment of windbreaks.

Plate 1—Banana plantation on alluvial soil, Serea Photo—P.R.O.

Alluvial Soils—Alluvial soils occur along rivers and streams and fall into two groups. Most important are the Levee Banks, which occur adjacent to the water and which are usually well drained and fertile. These are among the most suitable soils for banana growing except in places where they are subject to prolonged flooding or rapid movement of water. Next come the Flood Plains, which occur in the lower lying areas behind the levee banks and are usually associated with drainage problems. The soils of the flood plains are unsuitable for bananas unless they can be adequately drained.

On levee banks, providing the drainage is satisfactory and the soil has not been exhausted by over-cropping, the first crop of bananas could be grown without the use of fertilizers, although it would benefit considerably from applications of urea. This fertilizer alone may be adequate for a couple of years, after which the use of a general fertilizer mixture will become necessary; the leaf colour is a useful indication of when urea should be applied. The use of ammonium sulphate instead of urea is not advocated owing to its acidifying action on the soil and to the additional transport costs involved.

Colluvial Soils—These are found along the lower slopes of hills and in the bottoms of gullies, although in the latter case drainage problems are common. Colluvial soils are sometimes sufficiently fertile to support an initial crop of bananas; however, it would be advisable to maintain their fertility by using complete fertilizer mixtures as soon as possible.

Residual Soils—These are soils which are formed *in situ* as opposed to those soils which have been deposited by floods or washed down hills or slopes to build up colluvial soils. In general, the residual soils of the two main islands have a low natural fertility, but the soils of the younger volcanic islands of Taveuni and Koro are

Plate 2—Hillside plantation on colluvial soil, Navuakece Photo—P.R.O.

considerably more fertile and would be ideal for bananas.

In South-Eastern Viti Levu bananas can be grown very well on the red hill soils where these are sufficiently deep. However, for plantation growing of bananas, the use of complete fertilizer mixtures is essential as soon as the plants start to grow. These soils are not fertile and require liberal amounts of fertilizer; they are also subject to the detrimental effects of dry seasons. Since the margin of profit in banana growing is low, it is not advocated that these soils be used for the monoculture of plantation bananas until further experimental work has been done. For bananas in Fiji, it is essential to choose a suitable soil so as to get good growth and to limit the initial fertilizer requirements. Freshly cleared areas of any soils are always more suitable than those which have been cleared for some time; however, after clearing, there is an inevitable loss of soil fertility and, in the case of the residual soils, this loss is rapid.

PLANTING MATERIAL

Availability—A farmer who is already growing bananas and who wishes to change over to a properly maintained plantation system will have a supply of planting material available. But a farmer starting "from scratch" would probably have to buy his planting material at a cost of about £3 per 100 plants.

The grower would be well advised to maintain a small, unpruned area of fertilized bananas for the sole purpose of providing planting material. This area, provided that pests and diseases are carefully controlled, would give him good, disease-free plants.

It should be noted here that, while a plantation should be regularly pruned, or desuckered, it is not advisable to dig out complete suckers to provide planting material as this results in injury to the root system of the main stool and can well mean that too many suckers are left overlong in the main plant.

Selection—The future success of a banana plantation is largely dependent on the planting material used. Healthy, disease-free material is essential and care should be exercised in its selection.

Three types of planting material may be used, known respectively as butts, suckers and bits. The following descriptions are based on the work of Wills & Berril (1954).

Butts—these are obtained from plants which have already borne a bunch. The corm is dug up and the stem cut off four inches above the corm; after trimming and removing all the buds except the selected one it is ready for planting.

This type of planting material ensures the future sucker of a large food reserve and is more resistant to adverse weather conditions. However, it is seldom used because it is too bulky and is not readily available.

Suckers—These are the usual type of planting material used in Fiji; however, in the French West Indies (Caribbean Commission, 1957) they are only recommended as a last resort when there is no other alternative. If they must be used, suckers with narrow "sword" shaped leaves, well developed bases and tapering stems, must be selected. They should be about two feet high and no more than about three months old. Water suckers, which have spindly stems, broad leaves and undeveloped bases, are useless as planting material. A point to observe, when planting suckers is that the sides which are severed from the parent corm should all face in one direction along the row. New suckers will develop from the buds on the uncut surface.

Bits—these are considered to be the best form of planting material. A bit is a portion of a corm carrying a mature bud or eye and taken from a plant which has not yet produced a bunch but is 5–8 months old.

After trimming the corm, the stem is cut off about four inches above the corm. It will be noted that there are two buds near the upper surface on opposite sides of the corm. These make excellent planting material. The corm is split so as to have a bud in the centre of each half; the original growing point is gouged out and any extra buds are removed. If desired, the bits may be trimmed square to make handling easier, the minimum size being three inches in any direction.

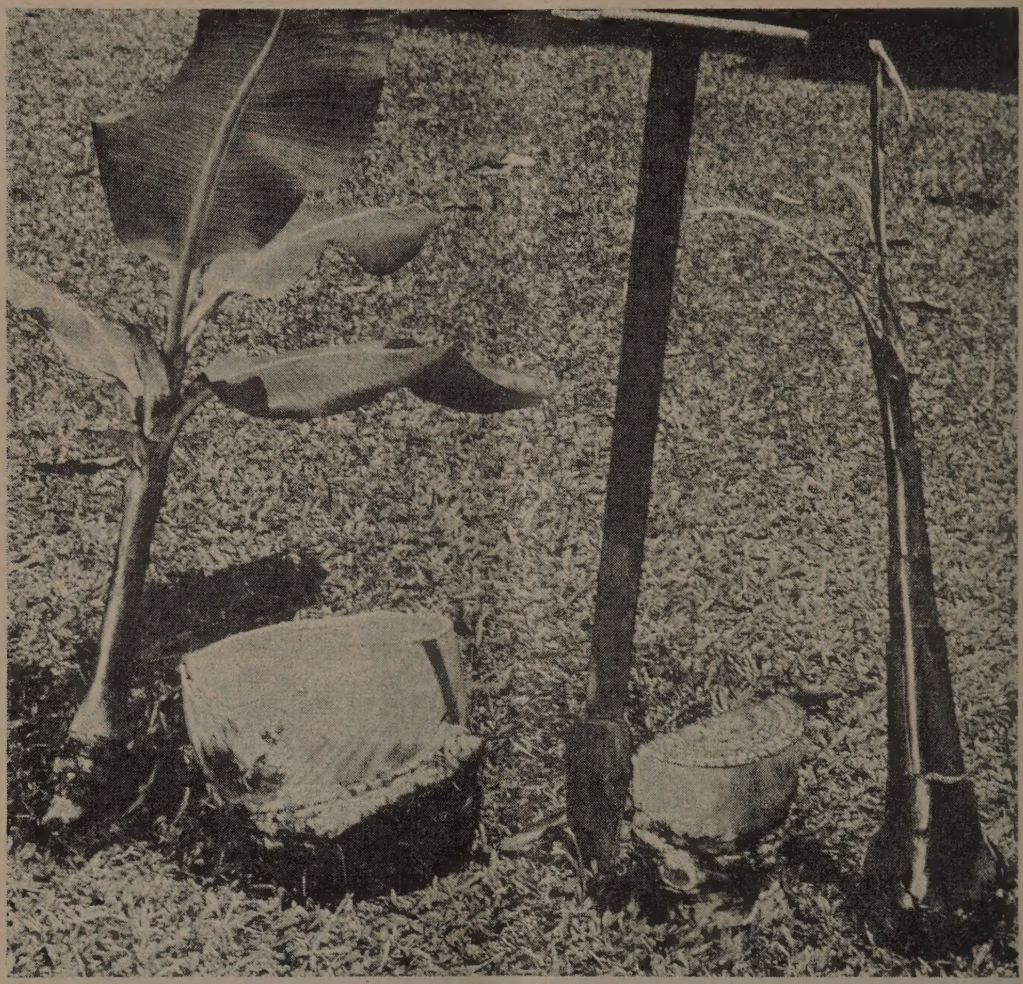


Plate 3—Types of planting material, showing unsuitable water sucker at left ; then—butt plant, bit and sword sucker. Note desuckering tool. Photo—P.R.O.

In addition to the two top buds, underground buds may be used but are less satisfactory. If used, they could also be trimmed square for ease of stacking and handling.

All forms of prepared planting material should be kept for one day before being planted so that the cut surfaces may dry out. In planting a new plantation it is also advisable to grade the various types of planting material and plant each grade in a separate block. This will result in an even stand and thus prevent overshading of the less vigorous plants.

At Serea, alternate areas have been planted with these various types of planting material, and, without question, the bits taken from corms are superior to suckers. They were slower in starting, but the plants later grew larger than the others and have maintained this increase up to their present fruiting age.

Depth of Planting—It is the usual practice to dig planting holes eighteen inches square and fifteen inches deep.

When digging the hole, the top soil should be placed on one side and the sub-soil on the other. Some top soil is then placed

into the bottom of the hole and the sucker planted so that the junction of the pseudo-stem and the corm is about six inches below the surface. The eye of a bit should be planted to a similar depth.

The remainder of the top soil should then be filled into the hole, followed by the sub-soil, and firmly trampled around the plant.

SPACING

This is a most important but complex aspect of banana cultivation and will depend on the use of fertilizers, machinery, soil type and topography. Some of the factors which are interrelated with spacing are discussed below.

The effect of close spacing on the ratoon crops must be considered. Wills (1947) states that under good growing conditions spacing has little effect on the first or plant crop, provided the plants are fertilized regularly and properly maintained. This is borne out by the appearance of the 4½ acres of 1,040 plants per acre on Mr. Phillips' area at Serea. But close spacing is of little value if greater production from the plant crop is achieved at the expense of the ratoon crop.

It is fundamental that a soil cannot support closely-spaced bananas for very long unless the soil fertility is maintained. If manures or fertilizers are not going to be used, wide spacing may slow down the loss of soil fertility and a spacing of 11 feet by 11 feet—the only published Departmental recommendation—should be adequate. This spacing, however, is almost out of the question in a plantation, as it involves too much weeding and requires a larger area to obtain a comparative output.

If spraying equipment or other machinery is to be used in the field, sufficiently wide access lanes must be maintained. For spraying with a " Micronette " low-volume sprayer, 11 foot lanes have been found to be satisfactory. It is therefore necessary to reduce the spacing between the plants along the rows in order to obtain the highest economic plant population.

With closer spacing weed growth is largely suppressed by the heavy canopy of banana leaves and, as a result, the cost of weeding is reduced. On the other hand, closer spacing is governed by the fact that sunlight must be able to reach an adequate leaf area to ensure proper fruit filling and maturing (Berril, 1956).

It must also be pointed out that the higher the plant population, the lower will be the overall management costs per plant.

The number of stools per acre throughout banana producing countries varies from 200 to well over 1,000 and depends largely on how the fruit is to be sold, whether as bunches, by gross weight, in hands, etc.

It is suggested that, in Fiji, spacings resulting in populations in excess of 700—800 plants per acre should be employed with caution, until further results are available. Mr. Phillips' bananas at Serea, spaced to give 1,040 plants per acre, are most promising at ten months old but before this spacing is generally recommended it may be wise to await the effects of the close spacing on his ratoon crop as some thinning out may be necessary.

The bananas are planted in paired rows 11 feet apart; there are three feet between the rows in a pair and the stools are six feet apart down the row, giving a population of 1,040 plants to the acre. The stools in a pair should alternate and not be opposite each other.

Further experiments are being carried out on this property with this type of layout, retaining the 11 foot lane and paired rows but altering the spacings in the paired rows so as to reduce the population to about 800 plants per acre. This spacing should prove to be satisfactory and it can be suggested with reasonable confidence that the ratoon crop will be successful. One of the obvious advantages of double row spacing is the control of weed growth.

The spacing first used at the Navuso Agricultural School, and now being used on several other areas, is proving satisfactory. Here the rows are 11 feet apart, with stools 5 feet 6 inches apart down the row, giving a population of 720 plants to the acre. The Manager of the 12-acre plantation considers that 11 feet x 6 feet (660 plants to the acre) might be an improvement.

Plate 4—Bananas in paired rows ; dalo should normally be planted down the wide lane
Photo—P.R.O.

Plate 5—Close-up view of paired rows Photo—P.R.O.

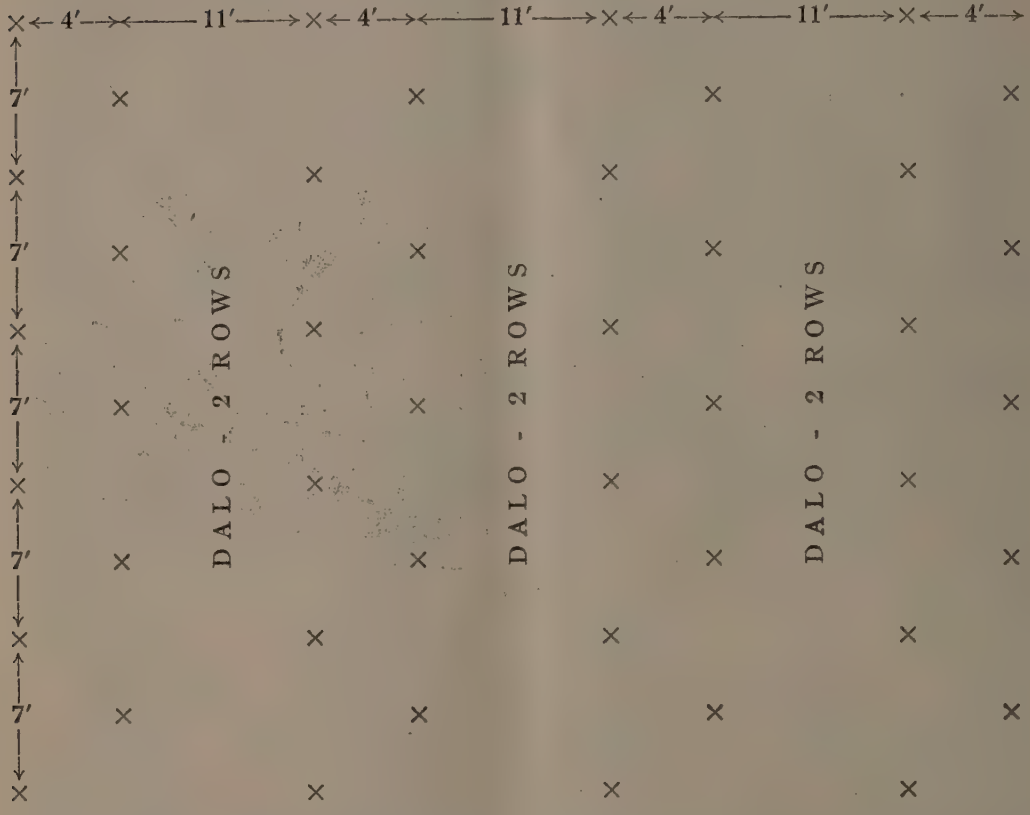
Plate 6—Single row planting ; the rows are 11 feet apart and the plants spaced 5 ft. 6 in apart in the rows Photo—P.R.O.

The following spacings are recommended pending the results of further trials:—

1. Single rows 11 ft. apart with plants 5 ft. 6 ins. (or 6 ft.) apart in the row; this gives a population of 720 plants per acre.
2. Paired rows 11 ft. apart with the rows in each pair 4 ft. apart and stools 7 ft. apart down the lines; this results in a population of 830 plants per acre and is illustrated in Figure 1.

Figure 1

PLANNED LAYOUT OF RECOMMENDED BANANA SPACING



When planting bananas with wide lanes and closely spaced stools down the rows, the direction of the lanes should run approximately east to west so that the plants can get the maximum exposure to sunlight.

Following the example used at the sixteen-acre Serea plantation, it is recommended that dalo be interplanted with all newly planted bananas; the dalo crop should find a ready sale which will more than cover the first year's outlay.

One or two rows of dalo, depending on the availability of planting material, can be planted down the wide lanes of both the Serea and Navuso type spacings; it should be planted two to four weeks before the bananas and it should be fertilized.

On hill soils, either of the foregoing recommendations, with the closely-spaced lanes running along the contour, can be tried—BUT ONLY IF FERTILIZERS ARE USED IN LIBERAL QUANTITIES.

FOLLOWERS

The one-bunch-one-sucker system could be used where there is a large number of stools per acre. In Queensland, Mitchel (1950) states that this appears to contribute to a long productive life, high yields and maximum financial returns. This system requires experience and knowledge of the rate of growth. If a plant takes twelve months to grow from sucker to maturity, then a sucker or follower should be allowed to come away every six months or so. After that a new follower would be kept

Plate 7—A bearing plant with follower. Another sucker will be allowed to grow when the bunch has been harvested Photo—P.R.O.

every time a bunch is harvested from that stool. On fertile soils, bunches may be harvested in nine months; this would mean that a follower should be allowed to come away at about four months. Followers will generally be slower growing than the plant crop. With wide spacing the system of having two followers has a lot to recommend it but it is not recommended for closely spaced bananas.

When desuckering, it is advisable to leave suckers which are growing in line, particularly if any mechanical implements or vehicles are likely to be used in the lanes. All other suckers should be removed.

The sucker selected as a follower should be deep seated; this is often but not invariably indicated by the fact that it breaks through the soil well away from the base of the parent plant (Wills & Berril, 1953). The selection of deep seated suckers prevents the stools from eventually sitting on top of the soil and thus being easily blown over by wind. The sucker should be spear-shaped, with a well developed corm and narrow, sword-shaped leaves.

Desuckering should be a monthly operation, otherwise it becomes a time-consuming job as the suckers get bigger. It should be done with a special desuckering tool; this can be obtained locally and causes a minimum of damage to the root system of the parent plant.

PROPPING

When a plant bearing a bunch is blown over it represents a considerable loss to the grower as it has taken 6 to 12 months to get to the bearing stage. Strong winds are prevalent in Fiji and when they are preceded or accompanied by rain, which softens the ground, the fairly tall " veimama " variety is liable to be blown over. The Dwarf varieties, such as Cavendish, are much more difficult to dislodge and rarely need propping.

Plate 8—This method of propping considerably reduces losses from wind damage Photo—P.R.O.

Since a large proportion of local plantations are likely to suffer from wind damage the farmer is well advised to ensure that all fruiting plants are firmly propped.

Single bamboos are normally used as props in Fiji; these, however, are easily dislodged during heavy winds and frequently penetrate deep into the plant tissues.

A superior form of support is a double prop made from two bamboo poles of equal lengths. These are bound together with wire or strong bark about a foot from one end, and the " V " or crotch is placed under the bunch stalk and against the stem while the legs of the support are spread out at an angle to the stem. This provides a firm support for the bunch ; it is not easily dislodged nor does it injure the plant.

FERTILIZERS

The use of fertilizers is essential if a banana plantation is to be maintained in a healthy and productive condition over a period of years. However, their use in the absence of good management is a waste of money.

The bananas must be desuckered and weeds, diseases and pests controlled. Only under these conditions is expenditure on fertilizers justified.

There is no evidence to suggest that special placement of fertilizers is necessary on any of the soils considered suitable for bananas. It is therefore recommended that all fertilizer be broadcast in a band twelve inches wide just inside the periphery of the leaves of larger plants, or adjacent to the base of newly planted suckers, 3 or 4 weeks after planting.

Plate 9—Banana fertilizer trial ; this is the unfertilized control plot at 10 months old ; compare fertilized plot in Plate 10 Photo—P.R.O.

Plate 10—Banana fertilizer trial ; plot with recommended fertilizer mixture, 10 months old. Note fruiting and general vigour in comparison with control plot in Plate 9 Photo—P.R.O.

Nitrogenous fertilizers are very necessary for banana growing. In the more fertile soils there may be sufficient nitrogen to keep the crop going for a time. However, bananas on most soils benefit from regular applications of urea, commencing from their early stages of growth and, where possible, it should be applied regardless of the soil fertility.

The following mixture with a 13.5:10:10 formulation is tentatively recommended for all alluvial soils where bananas have been grown for more than one or two years; for the higher alluvial terraces which have lost their original fertility, or alluvial soils where previous cropping has partly depleted the natural fertility of the soil; and for well drained colluvial soils around the foothills of slopes and valley bottoms, or terraces on the sides of slopes:—

3 parts by weight of Urea
5 parts by weight of Superphosphate
2 parts by weight of Sulphate of Potash.

The mixture should be applied at the rate of ¾ lb. per stool every three months; where there are more than 560 plants to the acre it is suggested that the fertilizer mixture be applied at the rate of 15 cwt. per acre. Responses to date indicate that this rate of fertilizer application may not be adequate or suitable for bananas grown on the red residual soils. However, 1 lb. per stool of this mixture has given promising results and could be tried on residual soils of suitable slope and depth.

At the rate of 15 cwt. of fertilizer per acre the cost is approximately £35. It will be shown in Part II of this article that a good yield has to be obtained to make this outlay economic within the price structure of Fiji bananas. This can only be achieved by the choice of a suitable soil, proper field management, and use of fertilizers.

The above tentative recommendation will have to be reviewed from time to time in

the light of experimental work which may point the need for varying the rate of application or the proportions of the component fertilizers. It is interesting to note that in some overseas producing countries applications in the vicinity of 1½ tons per acre are necessary in order to maintain productivity.

On fertile alluvial soils it may be possible to maintain production for one or two years by using nitrogenous fertilizer only; urea applied at the rate of 3 ounces per stool every three months, is recommended.

If fertilizers are not used in adequate amounts, only low average yields can be expected. But there is reason to believe that fertilizers, combined with a high banana population and proper management, should prove economic with the production of good quality fruit. A high plant population results in reduced weeding costs and the overall spraying costs per plant are much less. There is, of course, always the risk of high or even moderately strong winds which can set back a plantation and upset all expectations. In this connexion, it is estimated that in the Southern Division 70 per cent of all bananas are blown down every four years.

DISEASES AND PESTS

Bunchy-Top Disease Control—This is an aspect of banana growing which must be strictly controlled under a system of plantation management. In trials to date this disease has been responsible for the replacement of 7 to 10 per cent of bananas in the first year; however, the percentage rapidly decreases with the adoption of proper control measures; these are as follows:—

1. Try to obtain disease-free planting material. One way of ensuring this is to maintain an area of bananas, in which the disease is carefully controlled, for the provision of planting material.
2. All bunchy-top plants must be eradicated as soon as infection becomes apparent. Before digging out the diseased plant, pour or spray about half a pint of kerosene down and around the throat of the affected plant and any suckers attached to the stool; this is necessary to kill the aphid vectors of the disease. The following day the stool may be completely dug out and should then be taken outside the field and chopped into small pieces that will dry up in the shortest possible time. Eradication of the diseased corms is the only remedy for bunchy-top disease.

Where practicable, after the removal of the diseased stool and before replanting, it is advisable to spray around the hole with dieldrin solution (see below) to destroy any aphids which may have escaped the kerosene and fallen to the ground. If this is not done, replanting should be delayed for a few days.

Control of Banana Weevil Borer—The recommended control measures are based on those used on the Principal Agricultural Station where the borer has been successfully controlled.

It is not advocated that insecticides for the control of borer be applied as a regular routine, but only when observation, preferably confirmed by the use of traps, indicates that control measures are necessary.

The following control measures are recommended at the time of planting:—

1. Use only borer-free planting material.
2. Trim all the dead outer tissue from the planting material, taking care not to injure the selected buds; it is in this outer tissue that the eggs and large numbers of insects are found. Trimming must never be done in the banana field; it is also desirable to burn or spray all the trimmings.
3. Disinfect the planting material by immersing it in a drum of dieldrin solution (see below) for several minutes.
4. Where it is necessary to replant, two pints of dieldrin solution should be watered into and around the planting hole.

When heavy infestation is indicated in a plantation, the following measures are recommended:—

Where water is readily available, mix 1 ounce of 15 per cent emulsifiable dieldrin concentrate in a gallon of water (i.e. 1

part in 160). One gallon is sufficient to treat about five plants and should be watered on and around the base of every stool; a watering-can could be used for this operation. Using this mixture, one gallon of dieldrin concentrate is sufficient to treat about 800 stools, the cost of the dieldrin being around £3 0s. 0d. per gallon.

Where water is restricted, or involves too much labour in transport, dieldrin used as a dust has been proved to be effective in Australia. The rate of application depends on the concentration of dieldrin in the dust; using 0.5 per cent dust an application of about 1 cwt. per acre should be satisfactory.

Mention has been made of traps. These have the twofold advantage of partially controlling the borer and of indicating the degree of infestation. The traps are prepared by cutting a fresh pseudo-stem into 12–15 inch lengths, splitting these lengths and lightly dusting the cut surfaces with 0·5 per cent dieldrin or 2 per cent D.D.T. dust. Place the traps on the ground under a plant with the cut surfaces downwards. Another method is to use a pseudo-stem that has been cut off about one foot above ground level; remove another slice a few inches thick, dust the two surfaces and replace the slice with a small stone or stick to keep the dusted surfaces slightly apart. The insects are attracted to the freshly cut tissue and are then killed by the insecticide; the dead weevils may then be counted. In the French West Indies (Caribbean Commission 1957) it is recommended that traps be examined at three-day intervals and counts made of the dead weevils; where the total of three successive counts exceeds 40, a heavy infestation is indicated. Numerous traps should be set around the field under the plants.

Finally, field sanitation is important in banana cultivations to reduce the

Plate 11—Bunchy-top disease ; the unaffected plant at left is shown for comparison
Photo—P.R.O.

Plate 12—Corms damaged by banana weevil borer ; adult insect at top left centre

Photo—P.R.O.

breeding places of the borer. Uprooted or overturned corms should not be left lying in the field but should be chopped into small pieces; the same applies to felled or fallen pseudo-stems. When a bunch has been harvested the pseudo-stem should be cut off close to the ground and chopped up, not only in the interests of field sanitation but also to accelerate decomposition. It is also advisable to fill in any holes which form in the soil around the stools, as these tend to weaken the support of the plant and may provide a breeding place for borers.

SUMMARY

This article deals with the various field aspects of planting and establishing bananas and maintaining the plantation in a healthy and productive condition. Part II, to be published in the next issue of this Journal, deals with the economic aspects and discusses labour estimates, costings, returns and marketing.

There are two important omissions namely, the control of Leaf Spot or Sigatoka disease and the Banana Scab Moth; these will be dealt with in articles to be issued from the Principal Agricultural Station.

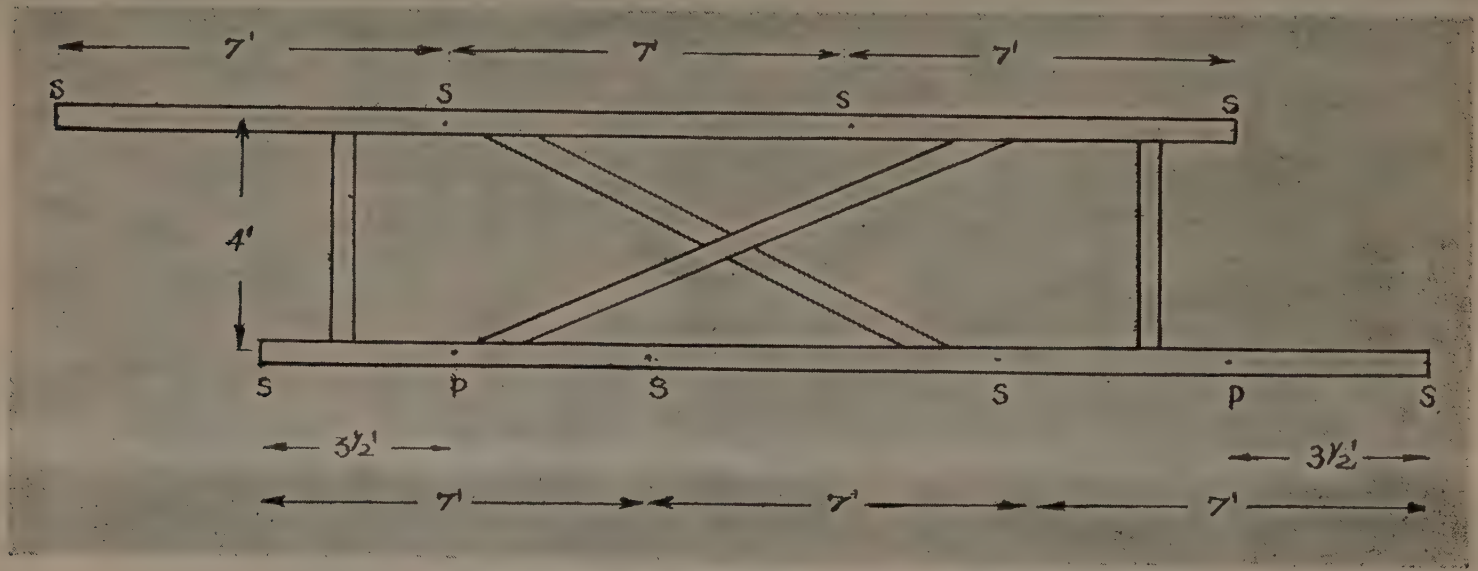


Plate 13—A Useful Template for Lining Planting Holes with Double-row Spacing

Two lengths of sawn lumber or bamboo, each 21 ft. long, are laid parallel, 4 feet apart, so that one length overlaps 3 ft. 6 ins. beyond the other ; they are joined by cross pieces and securely braced. These lengths are each measured off into three 7-foot sections and holes or slots cut to mark the 7-foot points (marked S)....On one length two points are measured off 3 ft. 6 ins. from each end and a piece of string or strong cord, 11 feet long, is attached to each of these two points (marked P).

The first double row is marked off by laying the template on the ground along the desired direction of the rows and placing markers in the ground at the points marked S ; after marking, the template is moved down the row in a straight line, and markers placed at points S in each new position. This gives a double row of markers, 4 feet apart, with the planting holes, represented by the markers, 'staggered' at 7-foot intervals down the rows.

The next and subsequent double rows are marked off in the same way, using the strings or cords attached to the points P to give the 11 foot spacing of the intermediate lanes ; the ends of the strings are extended to the opposite markers already positioned in the nearest line of the first double row, the template is positioned so that the strings are taut and the process of inserting markers at the points S is continued.

A VARIETAL DIFFERENCE IN THE NEED OF BANANAS FOR GOOD DRAINAGE

BY N. G. CASSIDY

For best growth conditions, the Veimama variety should have three feet of unmottled soil above the permanent water table, when grown under heavy rainfall.

Cavendish and Lady's Finger varieties are much more tolerant of restricted drainage than is the Veimama variety.

Although a regular and fairly high rainfall is necessary to provide good growing conditions for the banana, it is equally necessary that the soil's physical conditions should be good; otherwise the plants are quite unable to make use of any fertilizer or other ameliorative treatment.

This is well illustrated by the conditions which were found to exist in a fertilizer and green manure trial in which the plants on one side of the experimental area were stunted in spite of all treatments, whilst those on the other side of the area became progressively better towards the far side of the field. The stunted plants failed to make progress even though re-planting with fresh material had been carried out more than once.

Eventually the sub-surface conditions were investigated with the following results. Three holes were dug. One was put down on the high levee bank of the creek which constituted the remote boundary of the "good" area. Here the plants were well grown and productive. The soil in this profile was sandy and free of drainage restrictions. There was no evidence of a water table at least to 6 feet depth. The soil type was, in fact, Rewa sand.

The second hole was put down in the middle area where the plants were no better than of medium thriftiness; fruiting was rare. Examination of the profile showed a definite restriction of drainage.

At the third and low-level sampling site, remote from the levee bank, a 4-inch layer of blue clay was found and a water table existed at 19 inches from the surface.

Three days later the sites were re-examined, and equilibrium of the water table was indicated.

The following table shows the conditions existing at the three different sites. The sites lay in a line at right angles to the levee bank and were each chosen as typical of the condition of plant health that was being investigated.

TABLE 2

PLANT HEALTH AND DRAINAGE

(FERTILITY NOT A LIMITING FACTOR)

Site	Condition of Plants	Water-table	Soil colours
I.	Well-grown, leafy plants, bearing commercial bunches	No signs at 5′ 6″	(0–12)″ Dark brown (12–16)″ Brown (16–36)″ Dark brown (No mottling present)
II.	Poor plants, but had reached full height	At 30″	(0–12)″ Dark brown (12–24)″ Brown (Mottled with some bluish colours)
III.	Runts; original plants had been replaced; no further growth in 18 months	At 19″	(0–12)″ Brown (12—24)″ Yellow-Brown (Very mottled) (24–28)″ Blue clay layer.

The variety of bananas at sites II and III was Veimama and it is quite clear that, for this variety, a water table at 19 inches and the reducing conditions associated with it are enough to prevent even a bare increase in size of the original plants (suckers), whilst a water table at 30 inches and slight to moderate restriction of drainage served to prevent the attainment of full size, and the formation of fruit, by the plants.

Site I happened to lie in one of the Cavendish blocks of the experiment. However, the soil conditions were such that the thriving condition of the plants would have applied had any other variety been planted there.

Since the pattern of fertilizing did nothing to alter the pattern of plant health and growth, the experiment served to confirm the fact that impeded drainage and defective aeration cannot be ameliorated by raising the level of fertility. In other words, *poor plants will always result when drainage is impeded* even though, because of low fertility, good plants may not always result when drainage is free.

The Nausori area of South-Eastern Viti Levu, with a mean rainfall of 120 inches per annum, contains many such soil sequences. With the prospect of banana-growing becoming more important in this area as a result of the closing of the Nausori Sugar Mill, it followed that the chances of success with bananas would be closely linked with subsoil conditions. For this reason a survey was made of existing banana plantings, even though these generally constituted only a few stools on each farm.

It soon became apparent that a definite varietal difference exists with reference to tolerance of poor drainage, and the local farmers have, consciously or unconsciously, made use of this wherever it was necessary to do so. Veimama has been planted on the good sandy levee banks where drainage is practically perfect; but even short distances away from the levee banks, where drainage becomes more and more defective, it became impossible to find the Veimama variety and instead one found only Cavendish or Lady's Finger.

At each site where bananas were examined, their general thriftiness was noted and the soil conditions examined for signs of poor drainage and for the existence of a water table near the surface. The survey was made in March, the rainfall over the preceeding months being as follows:

January	4·3 inches
February ..	11·4 inches
March (to 14th) ..	10·6 inches.

No rain fell on 15th or 16th March and the survey was made on 17th March in fine weather. This record approximates to average rainfall for the period.

Four additional sites were examined eight weeks later, when the condition was very much the same as for the first series of observations.

TABLE 2

PLANT HEALTH AND DRAINAGE OF BANANAS AS RELATED TO THE VARIETY

Veimama Variety

	Mottling observed	Water Table (inches)	No. of effective leaves	Hands per bunch	Plant growth snd health
1	None	84	8	5	Good plants
2	None	66+	....	....	Good leafy plants bearing well
3	Brown at 30″	48	9	8	Big plants
4	Grey at 18″	46+	7	no bunch	Poor young plants
5	Grey at 20″	36+	8	4	Poor plants
6	Reddish at 9″ grey and red at 12″	36	7	8	Group of good plants
7	None down to 30″ ..	36	7	5	Satisfactory
8	Orange and grey at 18″ ..	36	11	no bunch	Plant only six months old but poor
9	None	34	8	9	Good plants
10	(Near permanent well) ..	30	6	2 (Dead)	Runts
11	Some blue colours ..	30	....	no bunch	Poor plants: not fruiting
12	Brown at 12″: blue at 24″	19	....	....	Original suckers barely surviving.
		Other Varieties			
C.13	Orange and grey at 18″ ..	46	10	6	Healthy
C.14	Orange and grey at 18″ ..	36	10	6	Satisfactory
LF.15	Brown at 36″	39+	6	5	Fair plant: much weed
LF.16	(Near permanent well) ..	30	....	4	Tall and healthy
C.17	Red & grey at 18″ ..	30	7	8	Satisfactory
C.18	Orange and grey at 30″ ..	30	9	7	Large plants and fair bunch
LF.19	From surface onwards ..	24	8	7	

NOTE.—Nos. 2, 11 and 12 are Sites I, II, and III of Table I.

The survey was made on the following basis:—

Whereas nothing was known with certainty about the nutritional status of the particular sites, the physical conditions could be determined by examination of a hole dug at the site. In this way, the depth to the water table could be determined and the previous history of aeration of the soil was presented in the pattern of mottling—grey or blue colours at the one extreme showing where there was iron still present in the ferrous state, and red mottles showing at the other extreme where reducing conditions had existed for a time but had given way to free aeration for a long period.

The sites examined in detail have been arranged in two series, the first for Veimama and the second for other varieties (Cavendish or Lady's Finger). Since Cavendish is by nature short in height, due consideration was naturally given to this factor when assessing its growth and thriftiness.

In each series the sites were arranged in decreasing depth of water table. The number of effective leaves and the number of hands of fruit per bunch are shown. Finally a column assessing plant health is given.

In reading the tables it is necessary to keep in mind:—

(*a*) that poor drainage can completely stop growth of the plants regardless of the fertility level of the soil;

(*b*) that all poor growth is not due to defective drainage; it may be due to low fertility.

It is desired to find the position where increasing closeness of the water table to the surface results in consistently decreased growth. For Veimama this occurred at about 36 inches where there

was a history of poor aeration, but in a soil free of mottles it seemed possible that a few more inches might be tolerated temporarily.

With the other varieties the limit did not seem to have been passed at 24 inches. At this depth of water table it was rather surprising to see a healthy stool of Lady's Finger consisting of large plants, one of which was carrying a seven-hand bunch; the surroundings were mostly wet rice land with water on the surface, and the soil was mottled from the surface downwards.

DISCUSSION

In spite of the limited extent of the survey it has shown clearly the varietal difference which exists between Veimama and the other two varieties commonly grown.

It will be seen that banana growing on the Rewa series of soils must be restricted to the sandy members of the series if the Veimama variety is grown; but cultivation may be extended to the slightly heavier soils if Cavendish or Lady's Finger varieties are grown. The texture of the surface soil profile, and the depth to the water table, should be ascertained before making a decision.

These findings could be of considerable importance to banana-growing in Fiji. The Cavendish variety has other advantages in that its small height makes it easier to dust for scab moth control and less susceptible to wind damage. The smaller size of Cavendish fruit may not be a disadvantage as compared with the longer Veimama fruit; it may well be that some overseas buyers, such as the cafe proprietor and the family man, might prefer them; however the requirements of our one overseas market, with a minimum fruit length of 5½ inches, do not offer much scope for this variety at present. With Cavendish, more plants can be grown per acre and the ratio of size of bunch to size of plant seems particularly favourable. Cavendish does, however, appear to be more susceptible to bunchy top disease.

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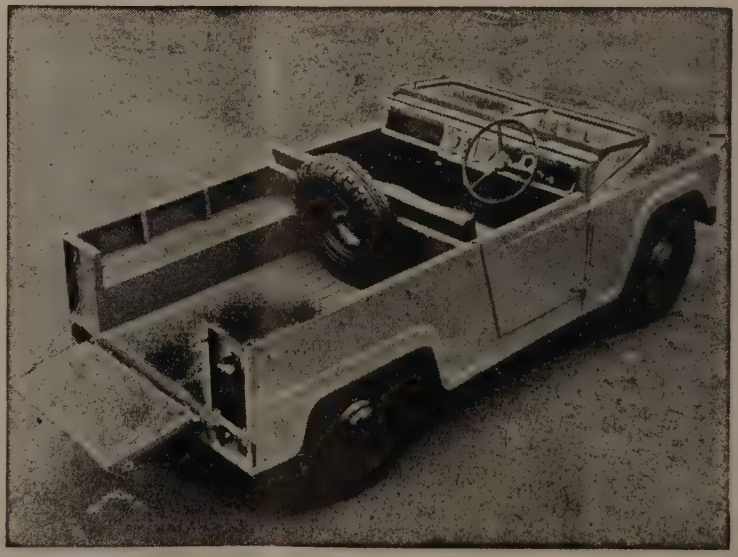

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LAND CONSERVATION . . .

IMPORTANT LAND CONSERVATION MEASURES BECOME EFFECTIVE IN 1960

BY C. E. WHITEHEAD

Two important Conservation Orders have been made by the Land Conservation Board under section 7 of the Land Conservation and Improvement Ordinance; the Orders come into force on 1st January, 1960.

The Land Conservation (Sledges) Order, 1959, prohibits the use of sledges, or "ghazitas", in specified areas; these areas include all or nearly all the dry-zone lands on the islands of Viti Levu and Vanua Levu. There is to be one amendment to this Order which will permit the use of sledges on land devoted to swamp or irrigated rice production.

This Order has been given wide publicity through the Press, radio broadcasts and pamphlets and it is unlikely that any person affected by the Order can fairly plead ignorance of it at this stage. Publicity has also been given to the alternative of using farm carts, together with details of their cost and availability. Good farm carts are being manufactured in Fiji and production can be stepped up to 200 or more a month; it is interesting to note that already over one thousand carts have been sold or are on order in Viti Levu alone.

The Land Conservation (Planting of Sugarcane) Order, 1959, requires that all sugarcane grown in the Colony shall be planted in drills or furrows running across the slope and at right angles to the fall of the land; in other words, all sugarcane must be planted on the contour.

This Order will not come as a surprise to any cane farmer. Many farmers have long been converted to contouring and, with the introduction of simple levelling instruments, it is expected that progressive farmers will start to run their own contour lines. But there are still too many farmers who need this Order to shepherd them into the conservation fold; from January 1st, 1960, they are on their way in.

PEST CONTROL . . .

AERIAL SPRAYING OF COCONUT PALMS TO CONTROL THE COCONUT STICK INSECT, GRAEFFEA CROUANI LE GUILL

BY B. A. O'CONNOR

In May, 1959, the first trial of aerial spraying against an insect pest in Fiji was carried out, the pest concerned being the Coconut Stick Insect.

Earlier attempts to control this pest had been unsuccessful, because there were no practicable means of applying insecticide to the foliage of very tall palms. Adhesive bands round the trunks of the palms caught large numbers of nymphs, but a proportion of the eggs dropped by the Stick Insect lodges in the crowns of palms. Nymphs which hatch from these avoid the sticky bands.

When a local aircraft operator decided to equip his Tiger Moth biplane with a spraying outfit, it was possible to test air spraying against Stick Insect. The spraying mechanism included a pump, driven by a wooden propeller, which provided pressure in the spray tank, and a boom fitted to the trailing edge of the lower wing, provided with 24 nozzles, one foot apart. The objective was to apply approximately two gallons per acre of an oil solution of B.H.C. when flying at 60 m.p.h. and treating one row of coconuts at a time, the distance between the rows of coconuts being thirty feet. Preliminary trials indicated that nozzles having a diameter of 1/32 inch would give the desired output. The spray solution was made up by mixing a solution containing 20 per cent gamma isomer of B.H.C. with diesoline.

Plate 14—Aircraft fitted with spraying outfit Photo—B. A. O'Connor

Plate 15—Spraying of palms in progress

Photo—B. A. O'Connor

A plantation on Taveuni Island was selected as a suitable site for the trial, an area of approximately 100 acres (60 chains by 17 chains) being chosen. This was divided into two plots, each approximately 8½ chains wide and 60 chains long. The plots were to be treated at the rate of 4 ounces and 8 ounces per acre of the gamma isomer of B.H.C. respectively.

Populations of Stick Insects on the palms were estimated by cutting off from 10 to 12 fronds from palms which appeared to be of average height and suffering from average defoliation. The cut fronds included a normal proportion of fronds of varying ages. They were lowered on to a tarpaulin at the base of the palm, and the Stick Insects on them were counted. The population of the whole palm was then calculated. Five palms were sampled, the populations being estimated as 118, 124, 141, 168 and 206, the average being 147 (4 male and 2 female adults and 141 nymphs). The high proportion of nymphs to adults and of young nymphs to more mature ones showed that the population was increasing.

The sampling of populations was carried out early in April, but unforeseen circumstances prevented spraying until mid-May. At this time the weather was not particularly favourable. Ideally, air-spraying should be done when there is little or no wind, and a dry period is preferable so that the spray fluid may not be washed off the foliage. It is a reasonable assumption that populations of Stick Insects had risen during the six weeks which had elapsed since sampling in April.

The first 50-acre plot was sprayed on May 18, the planned rate of application being 8 oz. of the gamma isomer of B.H.C. and 2 gallons of diesoline per acre. Actually the application turned out to be 10 oz. of gamma-B.H.C. and 2½ gallons of diesoline

Plate 16—Defoliation of coconut palm caused by stick insects

Photo—B. A. O'Connor

per acre. Spraying was done from 2 to 3 p.m. and from 5 to 6 p.m. There was too much wind, the aircraft had difficulty in maintaining its course and had to fly somewhat higher than was intended. Rain began to fall at about 3 a.m. the following morning and 20 points was recorded.

On May 19, between 10 and 11·30 a.m. the second 50-acre plot was sprayed. Again there was somewhat too much wind and the aircraft had to fly higher than had been planned. The rate of application was 4·4 ounces of gamma-B.H.C. and 2·2 gallons of diesoline per acre. Light rain fell between 3 and 5 p.m., only a few points being recorded.

In both plots a quick knockdown was obtained. A tarpaulin had been laid out on the ground under a palm in each plot. In the 10-ounce plot, an examination made two hours after spraying began revealed many dying Stick Insects on the tarpaulin and on the surrounding vegetation. In the 4·4 ounce plots, insects could be seen falling within an hour after spraying began. In both plots, dying Stick Insects continued to fall during three days after spraying.

To estimate mortality due to spraying, counts of populations in palms were made during several days after treatment. No newly-hatched nymphs were found on palms until three days after spraying. This indicates that the residual effect of the spray lasted for three days. Results of post-spraying counts are presented in the table below. These include the results of counts made by the owner of the plantation nine days after spraying, which exclude newly-hatched and very young nymphs which had obviously hatched since spraying was carried out.

Period after spraying	10 oz. Plot		4·4 oz. Plot	
	Number of palms sampled	Calculated population per palm	Number of palms sampled	Calculated population per palm
1 day	2	91	2	24
2 days	2	30	1	Nil
3 days	2	22	1	12
4 days	1	10	....	....
9 days	2	5	2	Nil

These figures indicated a very high percentage mortality. As new fronds emerge in the treated plots, they should show the effect of the drastic reduction in numbers of Stick Insects.

In theory, a second spraying of the palms is necessary to ensure long-lasting control of the pest. At the time of the first spraying, eggs of the Stick Insect which have been laid during the previous three months are present on the ground and in the crowns of the palms. The second spraying is designed to kill the insects which hatch from these. Life-history studies which were conducted during the cool season (May to October) showed that the maximum incubation period for eggs was 114 days. The shortest time between hatching of an egg and the laying of the first eggs of the next generation by a female insect was 125 days. Hence, if a second spraying is carried out four months after the first, it should kill all the insects which have hatched since the first spraying before any of them have begun to lay another generation of eggs.

The decision whether to spray a second time or not is one which a planter has to make on a basis of economics. Only experience will show whether it is best to spray once or twice and whether it pays to restrict spraying to defoliated areas or to carry out preventive treatment of the whole plantation. It would be necessary to consider factors such as the price of copra, the cost per acre of spraying, and the average annual loss of production due to attacks by the Stick Insect.

REFERENCE

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THE CONTROL OF SWEET POTATO WEEVILS

BY P. L. RHODES

Sweet potatoes, *Ipomoea batatas* Lam., or kumalas, as they are known locally, are rapidly increasing in importance and since 1955 the acreage devoted to this crop in Fiji has increased by over 50 per cent.

The Kumala weevils *Cylas formicarius* and *Euscepes postfasciatus* can cause considerable damage, occasionally decimating yields in severe cases. The adult weevils lay their eggs in small cavities which they puncture in the stem of the plant near ground level or directly into the tuber. The eggs hatch in about a week and the larvae feed in the vine or tuber for two to three weeks. Heavy attacks can damage the vines sufficiently to reduce the yield, quite apart from damaging the tubers so that they are unsaleable.

A series of trials was initiated at the Principal Agricultural Station, Koronivia, in 1956 in order to investigate the possibilities of controlling this pest by various methods.

The trials were sited on the alluvial Rewa Sandy Loam and Rewa Clay Loam which are typical soils of the alluvial flats in the wet zones of Fiji. The method of management worked out at Koronivia, and which appears to be satisfactory, entails preparing ridges 2½ to 3 ft. apart by tractor after preliminary ploughing and discing has been carried out. It is best to delay the ridging and planting operations until overcast or showery weather occurs in order to obtain a good "take" Slips or sections of vine, ten to twelve inches in length, are planted twelve inches apart along the ridges. When the crop is about a month old the rows are intercultivated, after which the ridges are rebuilt, making them as high as possible. It is best to do this operation in dry weather. This satisfactorily controls any weeds and, with a high plant population, the kumala vines will quickly cover the ground so that no more weeding will be necessary. The crop is lifted by fork. Ploughing out the tubers results in considerable damage and, as damaged kumalas rot very easily, is not recommended.

FIRST TRIAL

The first trial was observational and included eleven varieties which were planted in replicated blocks, half of each block being treated with Dieldrin. The method of treatment was to dip the slips for three minutes in 15 per cent Dieldrin emulsion 1:160 with water or one fluid ounce of Dieldrin to one gallon of water.

Table 1 shows the effect of dipping on the yield and percentage of infested tubers, i.e., those considered unfit for sale.

TABLE I

Variety	Control		Dipped	
	Yield lb. per plot	% weevil infested	Yield lb. per plot	% weevil infested
Black Rock	130	30	210	6
Niue	190	31	230	Nil
V 52	390	23	480	11
Kasailoa	420	20	630	10
Cosenivalu	310	19	440	3
Vula Tolu	350	12	420	5
Trinidad White ..	240	8	290	Nil
Naqia	70	6	170	8
Drivi Drivi	560	5	640	3
Samoa	70	4	60	11
Navuso Local	280	2	240	Nil
Total ..	3,010	14	3,810	5

It can be seen that the total yield was increased by 23 per cent while the percentage of unsaleable tubers was reduced from 14 per cent to 5 per cent, resulting in a 40 per cent increase in the yield of saleable tubers.

Quite a large variation occurred between varieties, both so far as yield and weevil resistance were concerned. Unfortunately, several of the most resistant varieties are also poor yielders and therefore have a low economic value. The varieties Drivi Drivi and Navuso Local, which are red and white-skinned varieties respectively, were selected as being the two most promising and these are now the main varieties grown at Koronivia.

The figures for weevil infested tubers shown in Table 1 only include those tubers which were so badly damaged as to be unsaleable. A considerable percentage was also superficially damaged.

SECOND TRIAL

In order to achieve better control, a second experiment was planned to include spraying treatments at two and three months from planting, in addition to dipping. Fifteen per cent Dieldrin emulsion was used at the same concentration of one fluid ounce to one gallon of water for both dipping and spraying treatments. The approximate rate per acre was 50 gallons of mixture or 2½ pints of concentrate for the spraying treatments.

The trial was planted on 4th June, 1957, and was harvested on 7th November, 1957. A Latin Square layout was used and the plot size was 1/80 acre. The results are summarized in Table 2.

TABLE 2

YIELD OF TUBERS IN TONS PER ACRE

	Sound	Superficially damaged	Badly damaged	Total
Control	0·3	3·0	1·6	4·9
Dipped	0·4	3·4	1·8	5·6
Dipped and sprayed at 2 months	1·0	4·7	1·8	7·5
Dipped and sprayed at 2 and 3 months ..	1·5	5·9	1·0	8·4

The dipping and spraying treatments had a marked effect on yields and a statistical analysis of the results showed that both the spraying treatments resulted in significantly higher yields than the control.

Table 3 shows the increase of saleable tubers for each treatment over the control and the cost of the materials for the treatment.

TABLE 3

	Increased yield tons per acre	Cost of materials
		s. d.
Dipped	0·5	8 9
Dipped and sprayed at 2 months	2·4	30 6
Dipped & sprayed at 2 & 3 months	4·1	52 3

Costs of labour and equipment are not included as these vary considerably under Fiji conditions.

The weevil infestation was so severe that even by dipping and spraying twice it was not possible to achieve anything like full control. Nevertheless, the total yield of tubers was considerably increased due to the partial control obtained. The vines in the control plots were so badly infested that they were dying off prematurely.

This experiment proved that dipping and spraying with Dieldrin is a most useful method of controlling kumala weevils, but is not sufficient in itself to give adequate control of really severe infestations.

One drawback to dipping kumala slips in Dieldrin emulsion became apparent in this trial, namely the damaging effect of the emulsifying agent on the leaves and stem tissues of the slips. If the weather at planting is dull and cool, or if the soil is fairly moist, this damage is not serious. If, however, the weather happens to be hot and dry during planting the leaves shrivel and blacken and the ability of the slips to survive is reduced. Thus it is inadvisable to plant in such weather, or, if it is unavoidable, the dipping treatment should be replaced by an early spraying as soon as the plants commence growing. No damage to growing plants has been observed using the recommended rates.

THIRD TRIAL

Following up the results already obtained, a third trial was laid down in 1958. This was similar to the second trial except that the resistant variety Drivi Drivi was used and the experiment was sited in a field which had not carried a crop of kumalas for a number of years. Owing to the risk of damage by the emulsifying agent in the Dieldrin emulsion, 50 per cent Dieldrin wettable powder was used in this trial at a rate of 2 oz. to 3 gallons for both dipping and spraying treatments. No damage to the slips was observed.

The slips were planted on 6th August, 1958 and the crop was harvested on 5th January, 1959. A Latin Square layout was used, the plot size being 1/87 acre. The same amount of Dieldrin was used for each treatment, i.e., 1.5 lb. per acre of the active ingredient, irrespective of the number of sprayings carried out. The results of the trial are shown in Table 4.

TABLE 4

YIELD OF TUBERS IN TONS PER ACRE

Treatment	Good	Superficially damaged	Total marketable roots
1. Control	12·0	2·0	14·0
2. Dipped and sprayed at 1 month ..	11·2	0·8	12·0
3 Dipped and sprayed at 2 and 4 months .	10·7	1·9	12·6
4. Dipped and sprayed at 1, 2½ and 4 months	11·5	0·7	12·2

The crop was very clean and damage by weevils was only slight; even in the control plots there were no severely damaged tubers.

As damage to the vines was not sufficient to affect yields, the weight of the damaged tubers was used to assess the value of the spraying treatments. It can be seen from Table 4 that treatments 2 and 4, which both included spraying at one month, yielded fewer superficially damaged tubers than the Control and treatment 2, which was not sprayed until two months after planting. However, a statistical analysis showed that these differences were not significant. Thus this trial has shown that by using weevil resistant varieties and following a suitable rotation it is possible to produce a good crop of kumalas without spraying. However, as it is not possible to forecast whether or not a kumala crop will be damaged by weevils, it is always advisable to include dipping and spraying operations as an insurance measure.

SUMMARY

Three trials were carried out at Koronivia in an attempt to find methods of producing weevil-free kumalas.

The first trial compared eleven varieties and showed that there is a large variation between varieties regarding resistance to weevils. It also indicated that dipping the slips for 3 minutes in 15 per cent Dieldrin emulsion, diluted at the rate of one fluid ounce in one gallon of water, gave considerable control.

The second trial was carried out with the susceptible variety Kasailoa on a weevil-infested piece of land to assess the value of spraying and to confirm the value of dipping. Damage by weevils was severe and the dipping and spraying treatments resulted in progressively increased yields. Dipping the slips in Dieldrin emulsion in hot, dry weather was found to cause severe scorch which resulted in poor takes.

The third trial included Dieldrin in the form of 50 per cent wettable powder which does not cause leaf scorch. 1·5 lb. per acre of the active ingredient were used for the spraying treatments. A resistant variety, Drivi Drivi, was planted. The field was one of a rotation and had not been planted to kumalas for several years. Dipping and spraying treatments were carried out in a similar manner to the second trial. An excellent yield was obtained and there was little damage from weevils. There were no significant differences in the amounts of damaged tubers between treatments.

RECOMMENDATIONS

Arising from this work the following recommendations can be made:

1. Use only varieties known to be resistant to weevils. A supply of planting material is usually available at the Principal Agricultural Station, Koronivia.
2. Plant kumalas in a rotation; the longer the period between successive crops the better. In theory, a one-year interval between crops is sufficient but, as there are always a number of volunteers which survive for some time after the crop is harvested, in practice the interval should be longer.
3. Select planting material from a weevil-free crop if possible. If this is not possible then take only the tips of the vines; these are less likely to be infested with weevils.
4. Dipping and spraying should be carried out as an insurance measure. The cost of the materials is only about 50s. an acre and the crop is worth anything up to £200 an acre, or more, if disposed of in small quantities.

   Dip the slips for 3 minutes before planting, using a mixture of 1 fluid ounce of 15 per cent Dieldrin emulsion in 1 gallon of water, except when the weather is hot and dry. Alternatively Dieldrin 50 per cent wettable powder diluted 2 ounces in 3 gallons of water may be used if available. Approximately 20 gallons of mixture are required to dip sufficient slips to plant one acre.

   Two sprayings should be given if possible, the first about six weeks from planting and the second six to eight weeks later. The same dilution, one fluid ounce to one gallon, as recommended for dipping, can be used and approximately 50 gallons of mixture are required per acre for each spraying.
5. Harvesting should be carried out as soon as the crop is mature. Any delay results in rapid destruction by weevils.

ACKNOWLEDGEMENTS

Advice and help has been freely given by the Entomology Division during the conduct of these trials, especially by the Entomologist, Mr. J. S. Pillai.

I am also indebted to the Officer-in-Charge of Stations, Mr. J. D. Yelf, for his help and encouragement in all phases of the work.

REPORT OF THE RHINOCEROS BEETLE TECHNICAL ADVISORY COMMITTEE OF THE SOUTH PACIFIC COMMISSION

BY B. A. O'CONNOR

A note on the meeting of this Committee in Suva last February was published in Volume 29, No. 1 of this Journal. The report of the Committee has now been circulated, and the Summary of Recommendations is printed below—

1. The Committee recommends that the South Pacific Commission initiates or supports experiments to assess the effectiveness of obstructive vegetation in coconut groves.
2. The Committee recognizes the value of attractants as an auxiliary in control operations, and recommends the continuation of enquiries into possible arrangements of trials of attractants in the South Pacific area.
3. The Committee recognizes the threat of the further spread of the Rhinoceros Beetle to uninfested areas; it believes that the condition of port areas is an important factor in this matter, and recommends the removal of breeding media and insecticidal treatment of palm crowns in port areas.
4. (*a*) The Committee recommends that Commission's insect pathologist, Dr. P. Surany, should work on the identification of pathogens and on other fundamental studies in a laboratory in a metropolitan country where complete facilities are available.

(*b*) It recommends, furthermore, that a trained scientist and a technical assistant be stationed at the existing laboratory at Muguga (Kenya).

(*c*) The Committee recommends that portions of the investigations be delegated to some well-equipped institution to which the South Pacific Commission should make a grant.

(*d*) The Committee recommends that an earnest endeavour be made by the South Pacific Commission to have this project taken up by a metropolitan institution, which would accept responsibility for the organization and continuity of the project.

(*e*) The Committee recommends that, as and when it may be practicable, a survey of the diseases of *Oryctes rhinoceros* in the Pacific area should be made. Further, as and when possible, an attempt should be made to obtain data on the cause of the two different types of attack on palms which occur in Africa (and also South East Asia) and Samoa respectively.

5. The Committee recommends that an entomologist be appointed to the staff of the South Pacific Commission for the purpose of studying parasites and predators in the region, and forwarding them to the South Pacific area.
6. The Committee recommends that the Commission's Pests and Diseases Officer, Dr. C. P. Hoyt, and possibly a collector, make an extended visit to the African region in 1959 in order to expedite this important work.
7. The Committee recommends that the Commission seek the services of Mr. F. A. Bianchi to search for parasites and predators in Central America.
8. The Committee recommends that attempts be made to determine whether *Trisciloa saussurei* will breed on the larvae of *Oryctes rhinoceros*.
9. The Committee recommends that the ecological investigations that are now in progress in Madagascar be continued until definite conclusions are reached regarding the role of parasites and predators.

It will be seen that Recommendation 1 deals with obstructive vegetation in coconut groves. It is proposed that the Commission should vote a small sum of money to permit experiments to be carried out in the Palau Islands by Mr. R. P. Owen, Staff Entomologist of the Trust Territory. Mr. Owen has directed control operations against the Rhinoceros Beetle in these islands since 1950, and he considers that there is considerable evidence to support the following conclusions:—

(*a*) Shrubs and trees growing in coconut groves interfere with the flight of the beetle from ground to palm-crown, and thus the palms receive considerable protection from damage by beetles.

(*b*) Dense surface vegetation such as creeping plants tends to prevent the beetle from breeding in rotting logs, stumps etc., which are covered by the vegetation.

In support of (*a*), Mr. G. S. Dun, Senior Entomologist in the Department of Agriculture, Stock and Fisheries, Territory of Papua-New Guinea, stated that cacao trees interplanted with coconuts appeared to reduce damage to palms. Dr. Paul Surany described observations which he had made in Sumatra and Malaya which tended to confirm (*b*). Also Dr. R. A. Cumber, in his publication "The Rhinoceros Beetle in Western Samoa", makes comments which agree with (*b*).

The Committee therefore decided to recommend that financial support be given to experiments which Mr. Owen is to conduct and which should throw more light on this subject.

Recommendation 2 deals with research into attractants. The South Pacific Commission is being assisted in this work by Mr. S. A. Hall, of the U.S.D.A. Pesticide Chemicals Research Laboratories. Already he has sent out a series of chemicals for trials of their attractiveness to adult *Oryctes*. A really efficient lure would be a very useful weapon against the pest, and the assistance of Mr. Hall is most valuable, as this is a very specialized field.

The measures suggested in Recommendation 3 for the treatment of port areas have been practised in Fiji for several years.

Considerable action has already been taken on Recommendation 4. Approaches have been made to an Institute in Germany which is working on disease of an insect allied to *Oryctes*. An assistant to Dr. Surany has been appointed, and Dr. Surany will shortly visit the Pacific area to make a survey of diseases already present there.

The question of the appointment of an entomologist, as suggested in Recommendation 5, will be decided by the Commissioners in October. Meanwhile Dr. Hoyt, of the South Pacific Commission's staff, is working in West Africa.

The proposals made in Recommendations 7, 8 and 9 have also been implemented.

New Agricultural Publication . . .

THE WEEDS OF FIJI

BY J. W. PARHAM

A bulletin describing the weeds of Fiji has been published and is on sale at the Department of Agriculture, Suva.

The bulletin contains botanical and general descriptions of most of the major and minor weeds of cultivation, pastures and waste places in the Colony, together with notes on their distribution. About 90 of the most common weeds are illustrated by line drawings.

The price of the bulletin is five shillings and orders may be addressed to the Director of Agriculture, Suva.

RURAL INDUSTRIES . . .

3. COFFEE

BY V. E. SILLS

Coffee is already being produced successfully in small quantities from rehabilitated early plantings in Viti Levu. What are the prospects of coffee production becoming an important minor industry in Fiji today? The growing and preparation of coffee and some of the economic problems associated with its production are discussed below.

According to an early Annual Report of the Department of Agriculture the growing of coffee was once an important enterprise in Fiji until the coffee leaf disease, *Hemileia vastatrix*, destroyed most of the bushes. Since those early times little further interest has been taken in coffee planting in Fiji although disease-resistant varieties of coffee have been available from overseas countries for many years.

Coffee has certainly had a chequered history in many parts of the tropics where it has been tried. In Ceylon, for example, Arabian coffee was extensively planted in the early 1860's yet by 1867 this coffee was virtually wiped out by the ravages of the leaf rust, nothing being known at that time of the means of controlling it. Despite severe hardship planters turned their attention to other crops, including tea, for which Ceylon has since become world famous. A similar experience with coffee was recorded in Java but instead of tea, Hevea rubber proved the most successful of the alternative crops tried.

On the other hand, the destructive leaf disease has never visited the enormous Arabian coffee growing areas of South and Central America. Instead, coffee producers in this part of the world have been faced with other yet equally serious difficulties, namely, how to combat the problem of over-production. Between 1931 and 1944 the Brazilian Government ordered the destruction of sufficient coffee beans to supply the world for three years—in an attempt to stabilize prices. Even today, after a postwar period of comparative prosperity, the South American coffee industry is faced with the same problem, a problem which, incidentally, also constitutes a threat to the flourishing coffee industry in East Africa.

Despite these drawbacks, however, a limited amount of coffee production in Fiji could prove an asset to the Colony, both for local consumption and for export to New Zealand and Australia. The small holder, in particular, with adequate labour for harvesting and with low production costs, should find in coffee a useful means of supplementing his income. One of the chief problems for him, perhaps, is to decide on the type of coffee to plant.

Of the several known species of coffee in existence three only will be discussed in this article. These are Coffea arabica (Arabian), C. canephora (Robusta) and C. liberica (Liberian).

Arabian Coffee—Arabica is by far the most important coffee in the world today, contributing 90 per cent of the world's supply. It is well known for its rich, aromatic flavour and, when well prepared, is much superior to either Robusta or Liberian coffees.

In the geographical position occupied by the Fiji islands Arabian coffee grows best at an elevation of about 2,000 feet above sea level. Under these conditions the coffee is favoured by a mean annual temperature of about 68°F, an average minimum of 63°F. and an average maximum of 77°F.

Arabica does not yield as well as the other species, nor is it as hardy. When grown under unfavourable conditions, for example, where the range of atmospheric temperature is on the high side, this coffee is particularly susceptible to the attacks of leaf rust—probably because of the tree's lowered state of health. Yet, when properly cared for, Arabian coffee gives very satisfactory returns per acre, a premium being received for its high quality.

Plate 17—Branch of three-year old Robusta in bearing, Naduruloulou

Photo—V. E. Sills

Robusta Coffee—Robusta is a hardy coffee and will grow well at sea level in the region of 18 degrees south of the Equator. It is a comparatively heavy yielder and is considered to be resistant to coffee leaf disease—a big point in its favour in those situations where the disease is known to exist.

Robusta coffee does not possess the fine aromatic qualities of Arabica but it serves a most useful purpose in commerce, firstly as a filler in blended coffees, and secondly as the main constituent of "instant" or soluble coffees.

The popularity of the instant type of coffee continues to grow year by year while that of the natural product, in the United Kingdom at least, according to the latest food statistics, remains static. And such is the extraordinary appeal of instant coffee in the United States that a liquid form of coffee packed in an aerosol container under nitrogen gas is under development; the nitrogen acts as a propellant when the release valve is depressed (1959, Food Manufacture).

Robusta was first discovered in the Belgian Congo and is now extensively planted in Uganda and Tanganyika where it has largely displaced former plantings of Arabica.

Liberian Coffee—As its name implies Liberian coffee has its origin in Liberia, West Africa. Liberian coffee trees differ from the trees of the other two species mainly in size, growing to a height of 40 feet and producing large berries. This coffee, like Robusta, grows well at sea level under the conditions prevailing in Fiji.

The quality of Liberian coffee is rated below that of Robusta and fetches the lowest price. As in the case of Robusta, because of its neutral properties, it is used mainly as a filler for blending purposes.

Method of Cultivation—The raising and cultivation of coffee are described at length by A. E. Haarer in his recent textbook entitled "Modern Coffee Production". The author acquired his experience in East Africa and gives most comprehensive accounts of seed selection, nurseries, pruning, shade, mulching and manuring, etc., followed by equally detailed and well illustrated information on the harvesting and preparation of the main kinds of coffee.

Briefly, coffee is generally raised as seedlings in a shaded nursery bed; when the seedlings have grown six pairs of leaves, usually at 8–12 months, they are planted out in the field. The spacing of plants depends on a variety of factors, including species, pruning system to be adopted, type of soil, rainfall and so on. Whereas it may be possible to raise over 600 Arabian coffee trees to the acre successfully in some favourable situations, in others less than 400 trees per acre may be better.

As to whether coffee should be given shade or not depends, according to Haarer, on the species of coffee and the environment and climate, and is a most difficult matter to judge. He goes on to say that whereas Arabian coffee may sometimes be found in situations where shade is unnecessary, this is seldom the case with Robusta; Liberian coffee, too, usually does best under a light shade.

In regard to the use of mulches it appears that better returns may be obtained from coffee when the ground is mulched than when it is clean-weeded, while clean weeding gives better results than a permanent cover crop or weed cover.

Yields—Normally Arabian coffee plants come into bearing in their 3rd or 4th year and, in later years, will yield an average of from 3 to 7 cwt. of clean coffee per acre, according to local conditions. Individual trees, however, have been known to reach yields as high as the equivalent of 17 cwt. of clean coffee per acre.

Robusta is a much heavier bearer, with yields ranging between 5 and 15 cwt. per acre.

Harvesting—Depending on the country in which the coffee is grown, the availability of water and the type of farmer, it is customary for the coffee berries to be either carefully hand-picked when red-ripe and processed by the "wet" method, or the berries are left on the trees until over-ripe and partially dried, and then shaken off on the ground, after which they are gathered up and dried on mats in the sun. This second rather crude but simple method is called the "dry" method.

The finest quality coffees, whether Arabica or Robusta, are always prepared by the wet method, that is, from berries that are just ripe. This is a simple matter when dealing with Robusta as the berries all tend to ripen at the same time and the pickers need only visit each bush once during the season. With Arabica, on the other hand, harvesting is more troublesome: the berries ripen unevenly so that the pickers are obliged to make several visits to each bush during the bearing season. The harvest is spread over a longer period but the cost of picking, per pound of coffee produced, is appreciably higher.

In Brazil and East Africa much coffee is produced by the dry method. This primitive procedure is undoubtedly responsible for the harsh liquoring qualities of the so-called "hard" Brazilian coffees, but apparently the dry method gives good results in East Africa.

Methods of Preparation

(*a*) *Wet Method*—The important feature of the wet method is that coffee carefully prepared in this manner virtually suffers no loss of quality up to the point of being dried in parchment, whereas in the course of preparing coffee by the dry method, the beans tend to acquire taints from the partly fermented surrounding pulp. Such coffee, when cured, is classified as "hard" and fetches lower prices.

The wet method calls for a copious supply of clean water and, when operated on a large scale, requires a heavy capital outlay on fermenting tanks, pumps, washing channels and so on. It is in fact a method most suitable for estates, although it is readily adapted to small holdings.

Briefly, the ripe cherries are put through five simple stages of processing:

(i) Washing. The cherries are separated from leaves, twigs, etc., on the way to the fermentation tanks.

(ii) Pulping. The seeds (in parchment) are separated from the surrounding fruit flesh and skins.

(iii) Fermenting. The pulped parchment is conveyed to fermenting tanks where the coating of mucilage is is removed by a natural process of fermentation.

(iv) Washing. After fermentation the de-mucilaged coffee is thoroughly washed.

(v) Drying. The now clean parchment coffee is sundried on trays or dried in a flow of hot air.

Washing and Pulping—A few of the details of the process of washing and pulping the ripe cherries are worthy of note: The cherries are conveyed to the pulping machine in a stream of water, the latter serving both to clean and to transport the fruit. Having entered the pulper the cherries are squeezed mechanically with just sufficient pressure to cause them to burst open, the mucilage-lubricated seeds being sharply ejected and discharged at one of the outlets oi the machine, while pulp and skins are directed into another. As the seeds contained in unripe cherries are coated with only a small amount of mucilage it is not difficult to understand why coffee pulping machines quickly become choked if unripe cherries are fed into them. It is perhaps fortunate that these machines will not process unripe berries, for the seeds from these immature berries do not make good coffee.

Fermentation and Washing—The pulped coffee, or wet parchment, is conveyed to fermentation tanks made of wood or of concrete, these being usually not more than 2 ft 6 in. deep. When full of coffee the water is drained off and covers are placed over the tanks to protect the fermenting coffee from the cooling effects of wind and rain. Fermentation of the mucilage coating of the parchment may be complete in 12 to 18 hours or it may take up to 48 hours, depending on the temperature. It is a simple matter to tell when the fermentation is complete: the beans grate together in a sloppy mass when squeezed in the hands.

After fermentation the tanks are filled with clean water and the parchment is then carried in a flow of water along connecting channels towards the driers; this operation serves the double purpose on large plantations of further cleaning the coffee and of grading it according to size, the larger beans coming to rest before the smaller ones.

Drying—Wet parchment coffee can be sundried under favourable conditions in 8 to 10 days. Alternatively, it may be dried in a current of hot air in 24 hours or less. For smallholders, a modified version of the hot-air drier at present installed at the Experimental Station, Naduruloulou, for drying cocoa would make a good coffee drier.

(*b*) *Dry Method*—Little need be added to what has already been said about the simple but crude method of drying the whole cherry. The latter takes longer to dry than wet parchment coffee and does not store at all well in the "dried" state. It is therefore important to send dried cherry to a local coffee curing works as soon as possible after drying.

The dry method of preparing coffee is undoubtedly attractive and satisfactory to the peasant class of farmer but it is clear that for the method to be successful two conditions must be fulfilled: there must be adequate sunshine for drying purposes and local coffee curing facilities must be available.

Coffee Curing—Curing is the term applied to the treatment of "dry" parchment or cherry coffee through all the stages of husking, hulling or peeling, followed by grading and preparation of the raw coffee for market. It is usual to cure coffee before it is transported any great distance, firstly because unless it is cured the coffee cannot be graded, and secondly because as a result of the curing process the bulk is appreciably reduced and therefore savings in freight are effected.

The hulling of parchment coffee, also called shelling or peeling, means the removal of the parchment covering and silverskin in one operation; the removal of the last

traces of silverskin is known as polishing, although it also refers to the "shine" which is put on the surface of the bean at the same time.

Small hand-operated dual-purpose machines are designed to hull both parchment and cherry coffees, but owing to the tough nature of the cherry coffee the throughput per hour of the latter is much less than for parchment, while the effort needed is also correspondingly much greater.

The grading of hulled or "green" coffee is accomplished in two stages: firstly, the beans are sorted according to size and shape by mechanical means based on the use of a suitable range of screens; it is at this stage that peaberries are separated from beans of normal shape. Secondly, because there is at present no satisfactory alternative method, handpicking is resorted to in order to provide a means of eliminating discoloured and insect-damaged beans.

The following note is quoted from "Modern Coffee Production" by Haarer:

"The raw coffee is first examined and classified, and though its plumpness and weight and evenness are considered, the colour is the most important of all. Planters should aim at obtaining a bluish-green to greyish-green colour and avoid any hint of brownness. Preference is given to this colour because many years of experience have taught coffee dealers that it is only in coffee beans of this colour that the finest liquoring qualities are found. The blue colour of underdried coffee is dangerously misleading because it soon fades and the beans deteriorate. At all costs the coffee must be dry.

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Note: Articles 1 and 2 in this series were published in Vol. 29, No. 1 of the Journal and dealt with Ginger and Cassava Starch. (Ed.)

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NOTES . . .

FERTILIZERS AND LIVESTOCK

BY A. D. DONALD

A local dairy farmer recently lost three cows through poisoning with urea which they obtained by breaking into bags of this fertilizer stored in a shed. It was somewhat surprising that the cows found urea sufficiently palatable to eat in the undiluted state.

Urea poisoning has been described on a number of occasions overseas since the practice has developed of including urea in rations as a substitute for protein. According to Smith & Jones (1957), quantities in excess of 2 or 3 per cent of the total ration on a dry weight basis are likely to produce poisoning.

Poisoning is thought to be due to the effects of ammonia or ammonium carbamate released by the decomposition of the urea. Symptoms, which appear suddenly and may lead to death in an hour or less, include twitching of the eyelids, lips and tail, ataxia and convulsions. Bloat and salivation with frothing at the mouth may be prominent. Respirations then become progressively slower and death follows. There is often a striking resemblance to strychnine poisoning.

Experimental work on the toxicity of urea to sheep by Clark *et al.* (1951) has shown that dilute acetic acid, given either into the rumen or intravenously, is an extremely beneficial antidote even when the symptoms are advanced. An oral dose of about 300 c.c. of acetic acid, suitably diluted with water, should be adequate for a 1,000 lb. cow.

In addition to urea, salts of potassium are also toxic; as a general rule, livestock should not be allowed possible access to any artificial fertilizers, whether in storage or after recent application.

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BOTANY NOTES

BY J. W. PARHAM

NAVUA SEDGE

The Department has been advised that the determination of Navua sedge as *Cyperus melanospermus* is incorrect. The correct botanical name, which has been found as a result of studying additional specimens from Fiji, is *Cyperus aromaticus* (Ridl.) Mattf. & Kukenth.

BATIKI BLUE GRASS

The Royal Botanic Gardens, Kew, have advised that the correct name for Batiki Blue grass is *Ischaemum indicum* (Houtt.) Merril, the name *I. aristatum* having previously been given owing to confusion as to which of Linnaeus' specimens was the type of *I. aristatum.* "Big" Batiki and "Small" Batiki are different varieties or forms of *I. indicum* which is a very variable species.

REVIEWS . . .

THE COCONUT PALM—A MONOGRAPH. By K. P. V. Menon and K. M, Pandalai. Ernakulam, India: Indian Central Coconut Committee, 1957, pp. 384. Rs. 38.00; 1.11.95.

This publication has been compiled in an effort to present all the available facts concerning the coconut in one book and the authors have, to a very large degree, succeeded in doing this. A great deal of the information is given in a summarized form, only the essential facts being presented, but this, in most cases, appears to be quite adequate, especially since there are comprehensive bibliographies at the end of each chapter and thorough author and subject indices at at the end of the book.

The chapter headings give an excellent idea of the scope of the book. There are chapters on importance and origin, general morphology, floral biology, varieties, breeding, climate and soil, production of quality planting material, field culture, soil conditions in relation to health and disease, pests, tapping, abnormalities, utilization of coconut products and certain problems in coconut research. There are one hundred and fifty figures, including many black and white photographs and a number of colour plates, and there are fifty-eight useful tables. The authors have obviously checked a tremendous number of references all of which have been carefully recorded in the text as well as in the bibliographies.

The chapter on the utilization of coconut products is, in parts, the weakest in the book. Relatively little space has been devoted to the making of copra and different types of driers, for example, are only very briefly mentioned. Considering the brevity of this section it is surprising the amount of space that has been devoted to the products manufactured from the husk. This is probably because the coir industry is of some importance in parts of India and the book, naturally enough, has a bias towards the Indian scene. But although India, Ceylon and the Philippines are often drawn upon for examples—obviously because of the amount of work carried out on the coconut in these countries—it must be emphasized that every attempt has certainly been made to quote examples from all countries where the coconut grows.

Most of the remaining chapters deal quite thoroughly with the subjects under discussion and it is impossible not to be impressed by the amount of trouble the authors have gone to in order to assemble all the available facts. Although a considerable number of research workers have studied the coconut, Chapter XVIII, " Certain Problems in Coconut Research ", outlines many important fields of research which still require investigation. A plea is made for a central information bureau which would act as a " clearing house " for all coconut research workers and this proposal seems to deserve support. The establishment of a central collection of world varieties (which would not be easy from the point of view of plant quarantine) and surveys of world varieties and of pests and diseases are also suggested. A number of important fields requiring further investigation are briefly described and all are worthy of serious attention.

" The Coconut Palm " is a most useful reference work because a tremendous amount of information has been made readily accessible to all those who have an interest in the coconut palm, be they research workers or plantation owners.

—J.W.P.

THE WEEDS OF FIJI. By J. W. Parham. Bulletin No. 35 of the Department of Agriculture, Fiji, 1959; 196 pp., price 5s.

The title of this Bulletin explains its contents. In 1956 the author collaborated with T. L. Mune in a description of the Declared Noxious Weeds of Fiji and methods of controlling them. (Bulletin No. 31, Revised Edition 1958). Mr. Parham has now dealt at comfortable length and yet in adequate detail with the remaining weeds of the Colony.

Enthusiastic gardeners may be horrified to find some of their favourate ornamentals classified as weeds; but it is a fact that several of the weeds described have become so after escaping from the confines of the garden.

The Bulletin is well indexed and contains close on 100 illustrations, while several appendices are devoted to references from a wide range of publications covering over one hundred and twenty years of work on the subject.

All in all, a useful and interesting publication, both to the research worker and to the farmer in Fiji.

Since the Bulletin was printed, one of the most important weeds has undergone a change of name. Navua Sedge, listed as *Cyperus melanospermus* (Nees) Valk. Suring, has been identified as *Cyperus aromaticus* (Ridl.) Mattf. & Kukenth. By any name—and this is the third in its relatively short history in Fiji—it is a growing menace to the pastoral industries of the Colony.—G.B.G.

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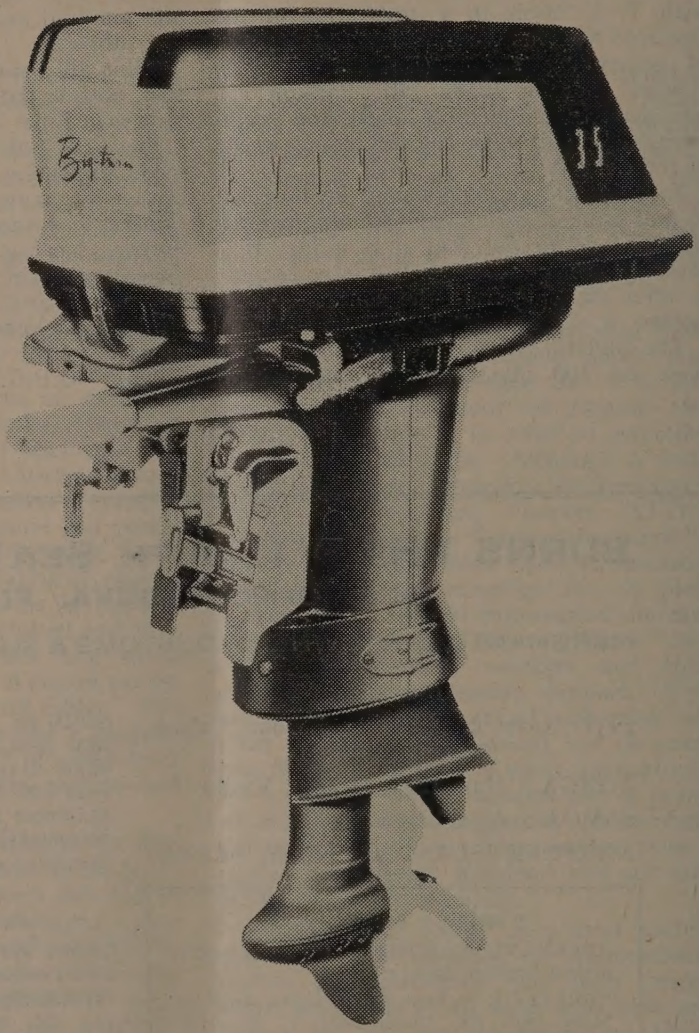

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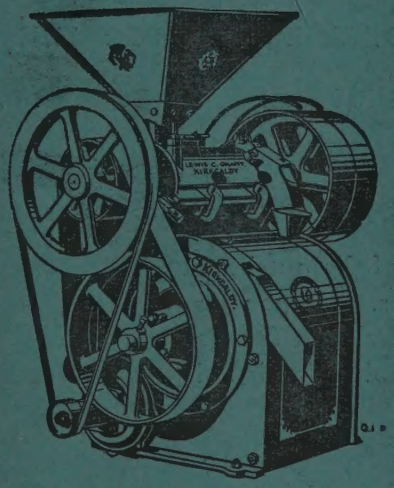

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